



## Richard Wynne Director

Commercial Airplanes  
Environment and Aviation Policy

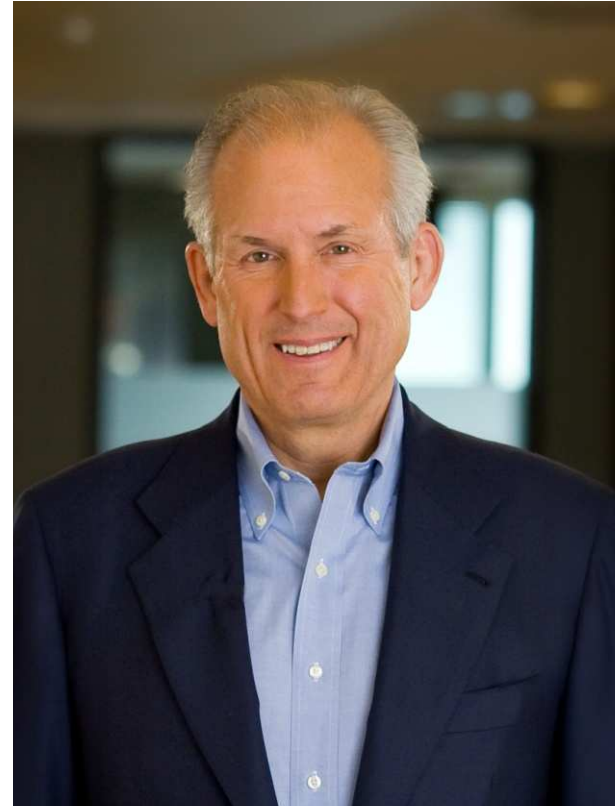


*July 27, 2011*

## *U.S. Department of Energy Biomass 2011* **Aviation and Sustainable Biofuel**

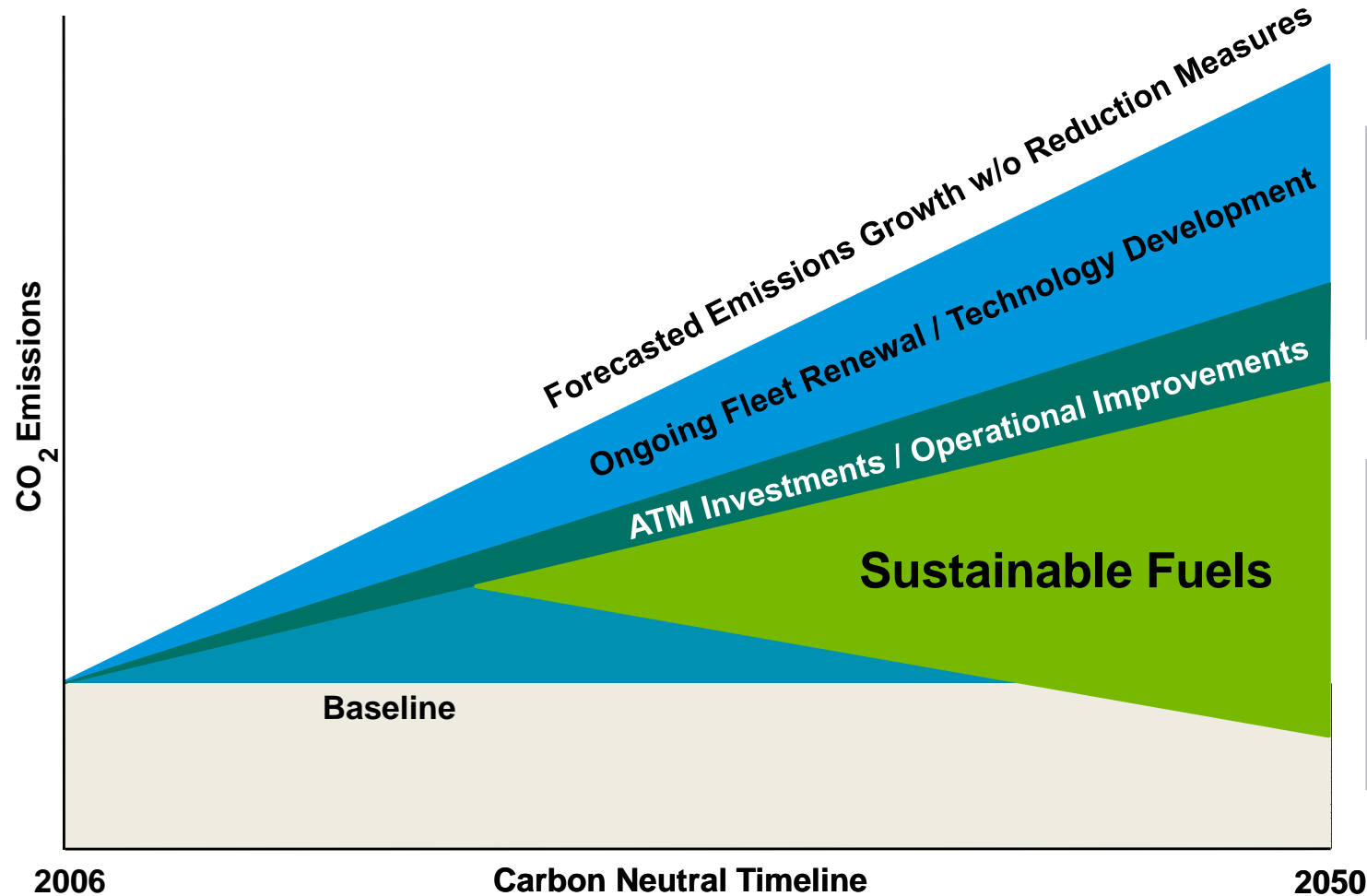
# Developing innovative solutions

***We recognize the importance of protecting our ecosystem. That is why we are unleashing the expertise of Boeing employees to design environmentally progressive products, research cleaner fuels, [and] enhance the global air traffic system to reduce the carbon footprint of air travel.***



Jim McNerney  
Chairman, President and CEO  
The Boeing Company

# The Challenge: Carbon-Neutral Growth



## Using less fuel

- Efficient airplanes
- Operational efficiency

## Changing the fuel

- Lower lifecycle CO<sub>2</sub>
- No infrastructure modifications
- “Sustainable Biofuel”

***Sustainable aviation biofuel is an essential growth enabler***

# Main Categories of Alternative Fuels

## Fossil Fuels



### Opportunities

- Significant supplies
- Proven technology

### Challenges

- Capital costs
- Energy, water intensive
- CCS tech. not mature

## 1<sup>st</sup> Generation Biofuel



- Steady supply
- Public policy support

- Use of food crops
- Airplane compatibility

## 2<sup>nd</sup> Generation Biofuel



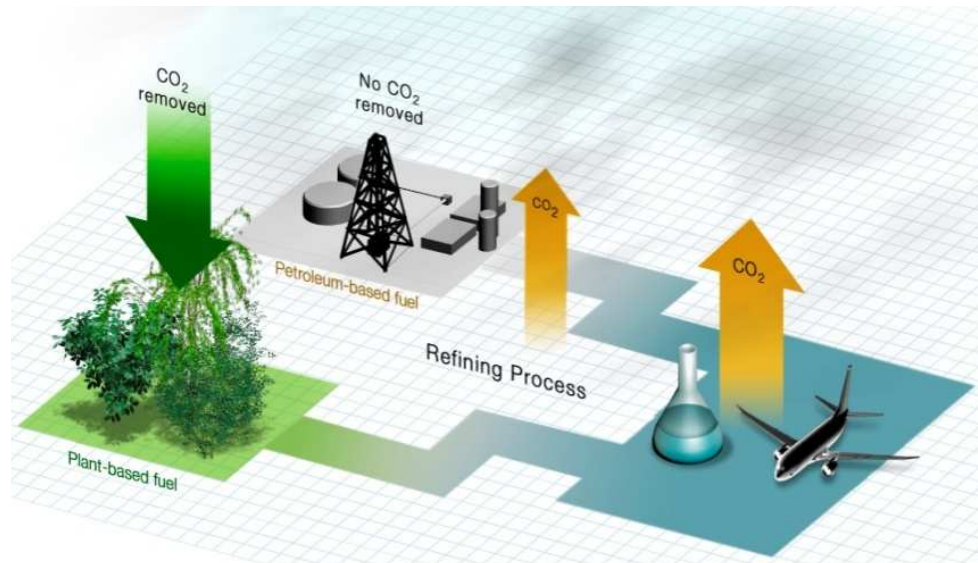
- Lower lifecycle CO<sub>2</sub>
- Avoids “food for fuel”
- Regional solutions

- Supply chain not mature
- Costs near-term

***We are focusing our efforts on sustainable biofuel***



# Sustainability Considers Environmental, Economic, Social Impacts



Lower CO<sub>2</sub> lifecycle



***Does not compete with food or promote deforestation***

# Sustainable Biofuel Strategy



**Enable the industry to achieve market viability by 2015**

## Five focus areas

**Fuel  
Approval**

**Feedstock  
Pathways**

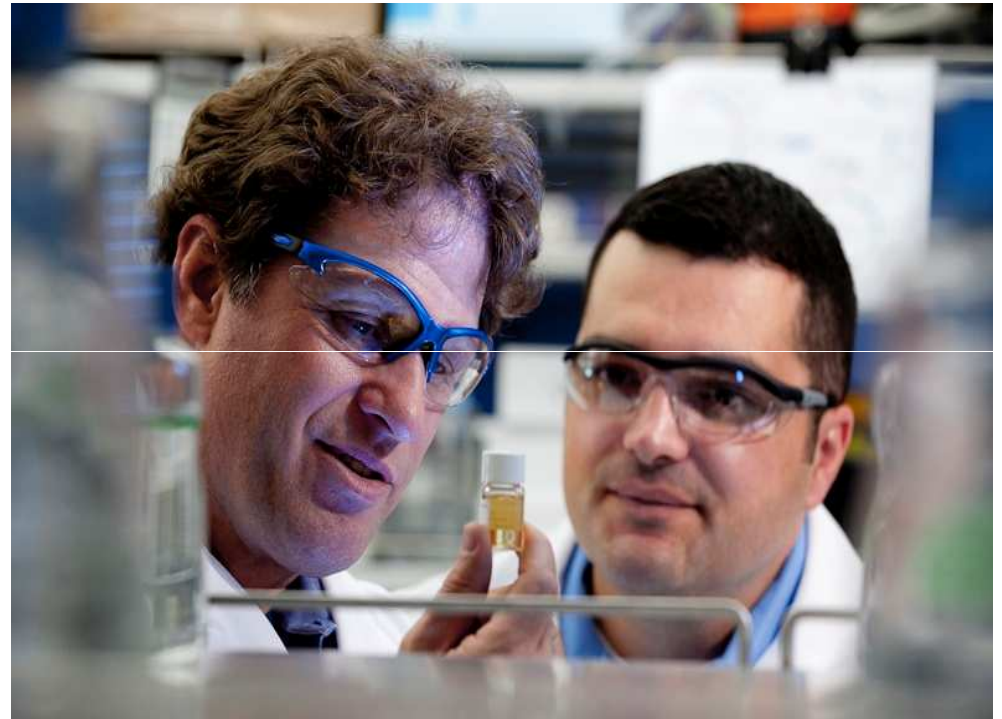
**Airport  
Infrastructure**

**Commercial  
Production**

**Advocacy**

***Acting as a Catalyst to Accelerate Broad Commercialization***

# Sustainable Aviation Biofuels: Tested Rigorously and Chemically Validated





# Sustainable Biofuel Test Flights



Feb 2008

**Virgin Atlantic**  
Coconut and Babassu



Dec 2008

**Air New Zealand**  
Jatropha



Jan 2009

**Continental**  
Algae and Jatropha



Jan 2009

**Japan Airlines**  
Camelina, Jatropha, Algae



Apr 2010

**F/A-18**  
Camelina



June 2010

**Dutch AH-64 Apache**  
Algae and Cooking Oil



# Sustainable Biofuel Strategy



Enable the industry to achieve market viability by 2015

## Five focus areas

BTL & HRJ  
ASTM  
APPROVED

Feedstock  
Pathways

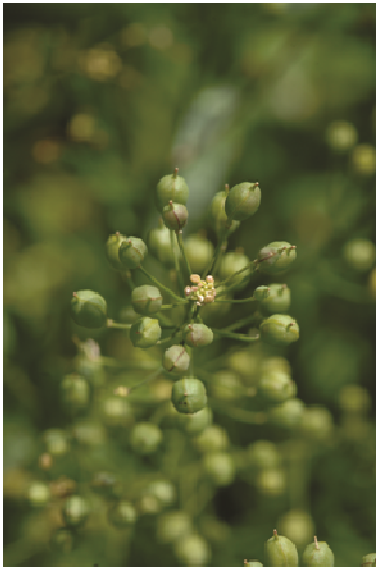
Airport  
Infrastructure

Commercial  
Production

Advocacy

*Acting as a Catalyst to Accelerate Broad Commercialization*

# Candidate Sustainable Biofuel Feedstocks



**Oilseeds**



**Algae**

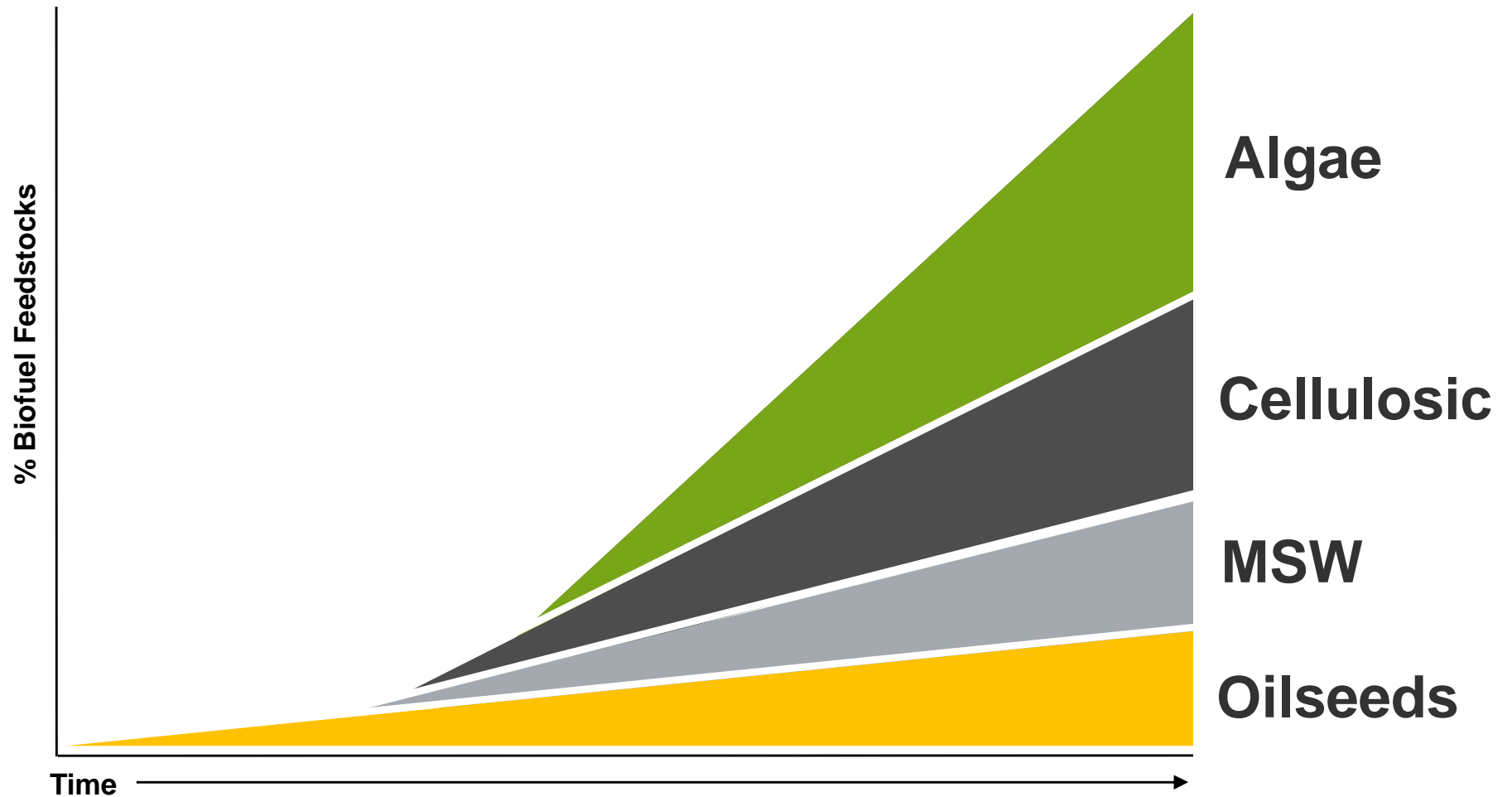


**Cellulosic**



**Municipal Solid  
Waste**

# Building Blocks to Creating Scalable Supply



# Candidate Sustainable Biofuel Feedstocks

## Camelina

Ready Now



### Challenges

- Limited total yield
- Tied to grain markets

## Jatropha

Ready Now

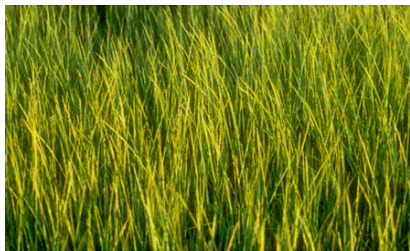


### Challenges

- Warm climates only
- Manual harvest today

## Halophytes

Ready in 2 to 4 years

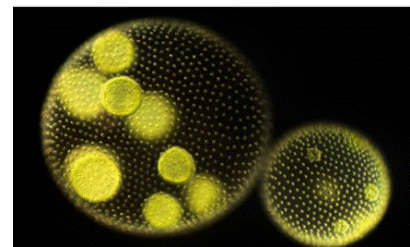


### Challenges

- Prove at scale
- Optimize agronomy

## Algae

Ready in 5 to 10 years



### Challenges

- Bio-optimization
- Competing approaches
- Processing costs

***Viability Based on Timing, Technology and Local Resources***



# Sustainable Biofuel Will Work in Existing Aviation Infrastructure

- Meets fuel performance requirements
- Requires NO change to airplanes or engines
- Requires NO change to infrastructure
- Can be mixed or alternated with Jet fuel from petroleum

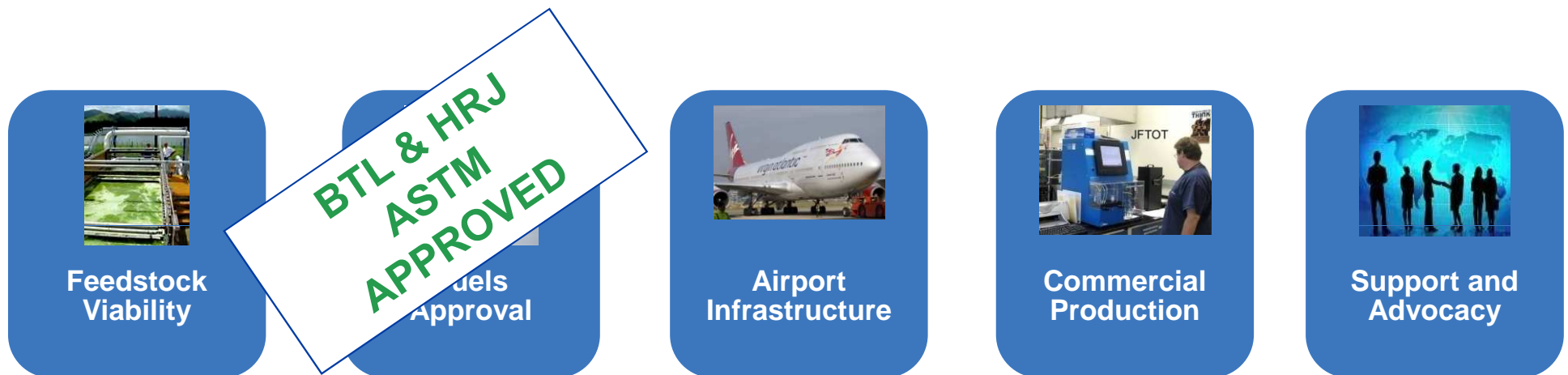


# Sustainable Biofuel Strategy

## Enable the industry to achieve market viability – by 2015

### Five Focus Areas

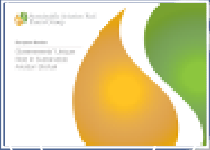
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***Acting as a Catalyst to Accelerate Broad Commercialization***

# Sustainable aviation biofuel projects around the world

## SAFUG-Europe Member Projects



## Working Together MOUs with CAAC, Air China, PetroChina



## Sustainable Aviation Fuels Northwest

## Farm to Fly



## Project Flight Path



## Latin America Jatropha Sustainability Study



## Masdar Research Project



## Life Cycle Analysis



## Aviation Biofuel Road Map

# Biofuels case studies – see [www.enviro.aero](http://www.enviro.aero)

A map showing current global development and research into biofuels





# Promoting Sustainable Biofuel for Aviation



*SAFUG is committed to advancing the development and commercialization of sustainable aviation biofuel*

# Promoting Sustainable Biofuel for Aviation



## Members:



## Affiliates:



# Recent Biofuel Activity

Boeing and American Airlines to Accelerate Quieter, Cleaner Aviation Technologies

Lufthansa begins scheduled commercial service on A320

ASTM Approves use of Bioderived Renewable Fuels

Sustainable Aviation Fuels Northwest regional study completed

Plan de Vuelo study completed

Virgin Atlantic Biofuel Test Flight

Boeing and Air China plan Biofuel Tests

Air New Zealand Biofuel Test Flight

Honeywell UOP flies Lindbergh's route across Atlantic

JAL Flight Brings Aviation One Step Closer to Using Biofuel

Continental Airlines Flight Demonstrates Use of Sustainable Biofuels

Boeing Issues First Latin American Study on Jatropha Sustainability

Biofuels Flightpath framework program announced

Finnair to begin regular commercial service

KLM flies first commercial passenger flight; announces regular service

Thomson Airways set for first commercial UK biofuels flight

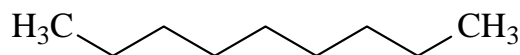
Boeing 747-8F Flies Historic Biofuel Flight: Seattle to Paris – all engines on biofuel

# The Chemistry of Typical Jet Fuel

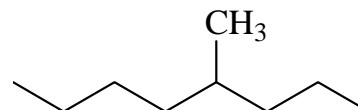
## Ideal Carbon Length C8-C16

### Paraffins

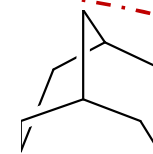
70%-85%



*Normal Paraffins*



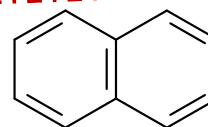
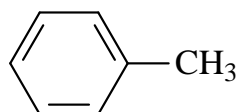
*Iso-paraffins*



*Cyclic Paraffins*

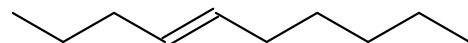
### Aromatics

< 25%

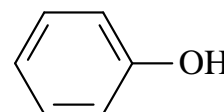
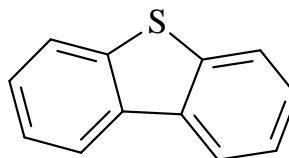


### Olefins

(<5%)



### Sulfur, Nitrogen, Oxygen Containing Compounds

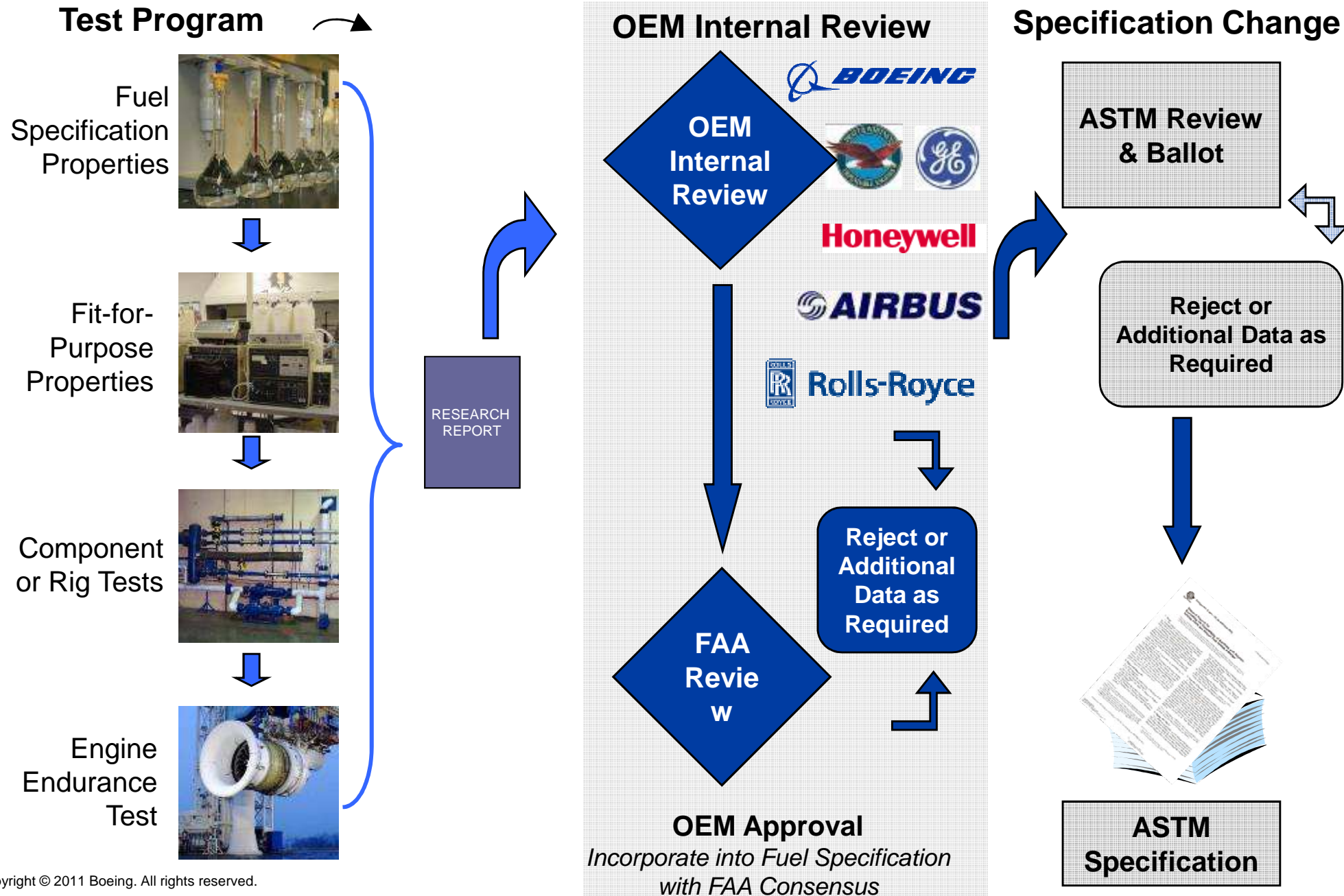


Acids, phenols, etc



# Fuels Approval Process – ASTM D 4054

Standard Practice for Qualification and Approval of New Aviation Turbine Fuels and Fuels Additives



# Policy Needs

- Recognition of fuel feedstocks
  - Parity for algae, oilseeds
  - Co-product approvals
- Government support of frameworks
  - Security for would-be producers
  - Permitting for production
- Long-term contracting authority for governments



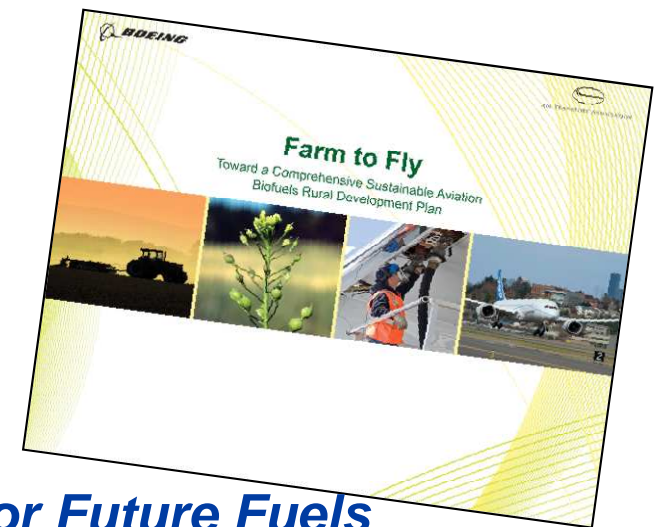
# Farm to Fly



- Initiative between aviation industry and US government agencies to accelerate biofuel commercialization
- What: Address challenges of cost, feedstock availability
  - Identify and advocate policy initiatives to launch end-to-end supply chain

Examples:

- Coordinate and integrate government policies
- Incorporate new feedstocks into existing laws
- US biorefinery capacity evaluation
- Potential to focus USG resources



***Air Transport Association/Boeing: Partnering for Future Fuels***

# First Transatlantic Biofuel Flight With Commercial Aircraft

**747-8 Freighter flown to Paris Air Show on sustainable aviation biofuel - July 2011**







# Sustainable Aviation Biofuel Progress Report



## Progress

- Flight tests – met / exceeded expectations
- Regional assessments – PNW, Australia, Mexico, ...
- Military platforms qualified
- ASTM HRJ SPK approval – eff. July 1<sup>st</sup>
- Commercial flights beginning – KLM, Lufthansa, Thomson/TUI, Finnair...

## Next Steps

- Continued emphasis on sustainability
- Research - expanded feedstocks/pathways
- Commercial production scale-up
- Stretch goal: 1st 1% by 2015 (~600 MGY)

***Great progress. Superior fuel. Early in the journey***

# Biofuel Policy Themes

## **Key focus areas:**

- Parity / Level playing field
- Acceleration – scale and cost
- Harmonization
- Pathways- road mapping
- Financing

## **Key regulatory areas:**

- Tax
- Agriculture, Forestry
- Energy
- Environment
- Transportation

## **Ongoing work areas:**

- Look for gaps, opportunities
- Craft recommendations, implement
- Coordination with national, international

# Top Six SAFN Recommendations

- Strategic focus on sustainable fuels for aviation
- Stable, long-term policy to attract investment
- Support for aviation fuels under RFS2
- State and local support of infrastructure and training
- Target regional R&D
- Incorporate sustainability criteria



